Monitoring Triplets

The Philips Avalon family of fetal monitors offers the ability to monitor and document up to three fetal heart rates (FHRs) externally using ultrasound. This is the very first such solution, industry-wide, using a single fetal monitor. There are currently no comparable set-ups for monitoring triple fetal heart rates. The problems encountered when monitoring triplets using several devices are overcome by this new, integrated solution. This application note provides an overview of monitoring triple fetal heart rates, and describes the features and technologies Philips builds into its fetal monitors to make reliable triplets monitoring possible.

Monitoring Triplets

While offering a ground-breaking solution to monitor triplets using only one fetal monitor, the methods Philips uses to achieve this are essentially an extension of the methods used for monitoring twins. What applies to twins monitoring also applies to triplets:

- Each fetal heart rate is monitored by a separate ultrasound transducer.
- You can plug Avalon ultrasound transducers into any of the four sensor sockets on the monitor, the order in which you do this does not matter. The monitor recognizes the transducer and allocates a channel to it automatically.

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- You can choose to listen to the fetal heart sound coming from each transducer, for one transducer at a time (see “Fetal Heart Sound Source Selection” on page 2).
- Each fetal heart channel has its own numeric display on the monitor’s screen.
- Each heart rate is documented as a separate trace on the fetal recorder.
- All traces are transmitted to a Philips OB TraceVue obstetrical information and surveillance system.

However, it is important to be aware that monitoring three FHRs is more difficult than monitoring single or twin FHRs. The nature of the application increases the likelihood that the same heart rate is being recorded by more than one transducer. See “Cross-Channel Verification” on page 2 to see how Philips addresses this issue.

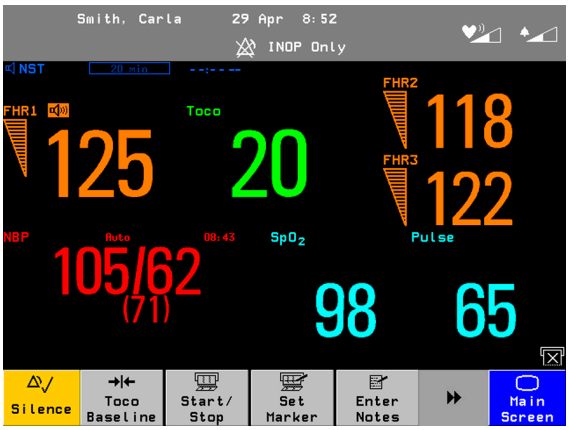
We recommend you also monitor the maternal pulse via SpO_2 to avoid the possibility of mistaking the maternal heart rate (MHR) for the FHR.

Helpful Features

In this section, we look at the helpful features built into Philips fetal monitors responsible for making the monitoring of triplets both accurate and convenient.

Automatic Screen Layout

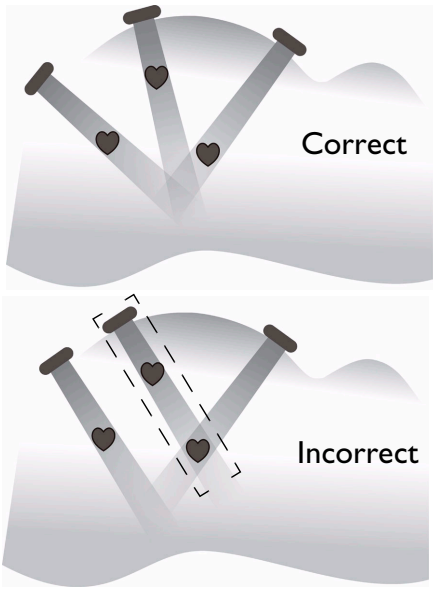
The Avalon fetal monitor automatically recognizes which transducers are connected and adjusts the screen layout to ensure that all measurements, both maternal and fetal, are displayed optimally. No user interaction is required.



Typical Triplets Screen Layout

Fetal Heart Sound Source Selection

Position the transducers using the fetal heart sound on the monitor’s loudspeaker. Make sure that each transducer picks up the signal from only one fetal heart. If necessary, identify the FHRs using independent means, such as an ultrasound scanner.

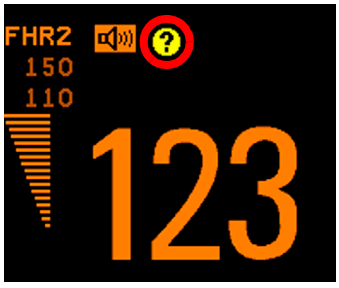


Avalon fetal monitors let you select the fetal heart sound coming from each transducer. You can do this for one transducer at a time. Being able to listen to the sound of each transducer separately lets you position the transducer more accurately than if the sound output from the loudspeaker allowed a mixture of more than one heart rate sound.

Cross-Channel Verification

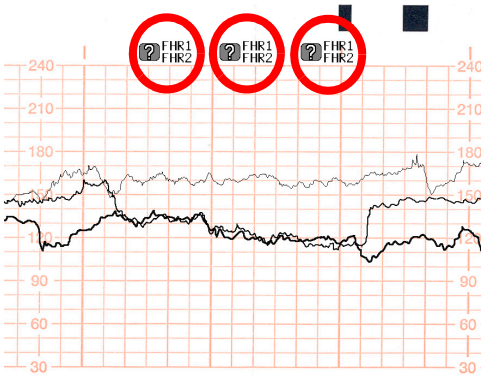
The monitor’s **Cross-Channel Verification** (CCV) feature can help significantly to reduce the possibility of mistaking one heart rate for another, for example, the maternal heart rate (MHR) for the FHR.

CCV indicates when the same heart rate is being recorded by different transducers. On the screen, the coincidence indicator ? is displayed next to the numeric on the screen...



Coincidence Indication on the Screen

...and ? is repeatedly printed on the trace after about 30 seconds after detecting the coincidence, showing which heart rate channels are coinciding.



Coincidence Indication on the Trace

CCV compares all fetal and maternal heart rates continuously and indicates when multiple channels are picking up the same signal. This means when monitoring triplets and maternal heart rate simultaneously, CCV will compare the values from all fetuses and each of these values with the maternal heart rate.

When the maternal heart rate and fetal heart rate are being monitored, CCV will alert you when the values could be from the same source. This may happen following fetal or maternal movement, where the fetal heart is no longer within the ultrasound beam, and the transducer is picking up a signal from another source, most likely from a large maternal blood vessel or another fetal heart.

Note: Be aware that a maternal heart rate trace can exhibit features that are very similar to those of a fetal heart rate trace, even including accelerations and decelerations. Do not rely solely on trace pattern features to identify a fetal source.

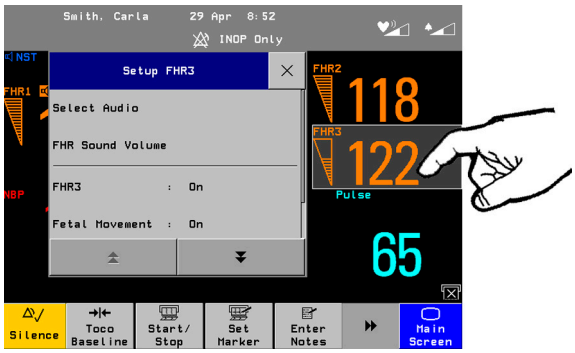
CCV technology helps reduce potential legal liability associated with continuing to monitor an incorrect heart rate.

When CCV detects coinciding heart rate signals, you are alerted within approximately 60 seconds to check the traces and potentially reposition the transducers as appropriate to detect all three FHRs correctly. If necessary, identify the FHRs using independent means, such as a stethoscope or an ultrasound scanner.

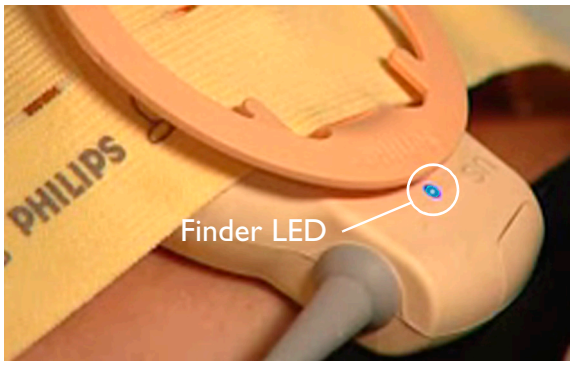
Easy Transducer Repositioning

When monitoring triplets, the need may arise to reposition the ultrasound transducers relatively often compared to when monitoring a single fetus. To allow rapid transducer identification, and therefore correspondingly quick transducer repositioning, each transducer is equipped with a **Finder LED**.

Touching a FHR numeric on the screen...



...illuminates the bright, blue Finder LED on the corresponding transducer.



Transducer Finder LED

This allows you to identify at a glance which transducer is monitoring which heart rate channel. Reposition the transducer using sound, and fix in place when the signal quality indicator shows a good signal.

Position each transducer so that it picks up the signal from only one, distinct fetal heart.

Trace Separation

The baselines of multiple FHR traces are often very similar, and when this occurs, independent trend interpretation can be challenging. Philips fetal monitors have two complementary features to help: Grey Scale Recording and Trace Separation.

To ensure that the three heart rates are easily distinguishable on the trace recording, Philips uses **Grey Scale Recording**. With Grey Scale Recording, the fetal heart rate trace recorded for the first fetus (FHR1) is thicker (darker) than that recorded for the second fetus (FHR2), which in turn is thicker than

that for the third fetus (FHR3), with no loss in variability.

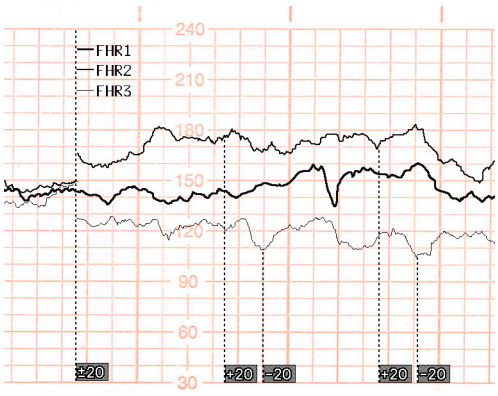
The **Trace Separation** feature separates the baselines on the recording. You can choose to separate the baselines on the recorder print-out by an offset of 20 bpm, so that the trace for FHR2 is shown 20 bpm higher than it really is, and the trace for FHR3 is shown 20 bpm lower than it really is. The value for the fetal heart rate displayed on the screen is, of course, the real fetal heart rate.

You can turn off the trace separation feature and return the FHR trace to its original baseline anytime you wish.

When trace separation is turned on:

- The recorder prints a dotted line labelled with the three FHRs at the top, and ±20 at the bottom.
- The trace FHR2 is offset by +20 bpm, and the trace for FHR3 is offset by -20 bpm.
- The recorder prints a dotted line labelled +20 across the FHR scale, to identify the trace for FHR2.
- The recorder prints a dotted line labelled −20 across the FHR scale, to identify the trace for FHR3.
- The FHR trace is labeled +20 and −20 every 5cm.

The following trace shows trace separation switched on.



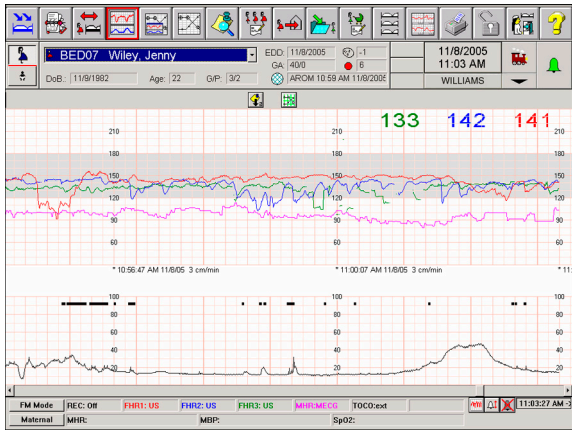
Trace Separation Switched On

Even though the traces for FHR2 and FHR3 are offset, the numerical FHR values displayed on the monitor remain unchanged. Subtract 20 from the recorded trace for FHR2 to manually determine the true FHR2. For example, if the recorded trace shows 160, then the true FHR is 140. Similarly, add 20 to the recorded trace for FHR3 to obtain the true FHR3.

Triplets and OB TraceVue

Triplets Surveillance, Alerting and Trace Archiving on OB TraceVue

Triplets monitoring on an OB TraceVue obstetrical information and surveillance system is not possible using an RS232 connection. To address this limitation, Philips Avalon fetal monitors are now available with a LAN interface[1], another industry first. When connected to an Avalon fetal monitor over a LAN connection, Philips OB TraceVue supports triplets surveillance and complete archiving, including Cross-Channel Verification[2].



OB TraceVue Screen Showing Waveforms for Triplets and Maternal Heart Rate

Triplets monitoring with the Avalon fetal monitor in combination with OB TraceVue, addresses the legal requirements for the complete archiving of traces for all three fetuses together with the mother.

Automatic Upload of Triplets Trace Data on an OB TraceVue System

An Avalon fetal monitor stores trace data, including annotations, in its internal backup memory, and this applies for single, twins or triplets monitoring. This allows the monitor to recover trace data that would otherwise be lost under certain circumstances. This trace data can be automatically retrieved and printed in the event of the paper running out, or automatically uploaded to an OB TraceVue system (LAN connection only, OB TraceVue Revision E.00.00 or higher), allowing continuity of data.

When the OB TraceVue system reconnects to the Avalon fetal monitor and detects that there is trace data in the monitor's backup memory that has not yet been transmitted to the system, this data is

1.Avalon FMxx fetal monitor with software revision D.00.00 or higher.
2.OB TraceVue Revision E.00.00 or higher.

transferred at high speed to the system. No user action is required.

The exact length of the recovered trace will vary depending upon the amount of trace information, but will cover at least one hour of trace data, regardless of how many parameters are being measured.

The Technological Challenge

Monitoring multiple fetal heart rates accurately and reliably poses a number of technological challenges. For example, several ultrasound transducers applied to the same patient can interfere with each other, generating noise on the loudspeaker output and preventing the correct calculation of the heart rate. Sometimes, even an artificial heart rate can result.

There are three quite different approaches to try to solve the problem of interference:

A. Using significantly different ultrasound frequencies for each transducer.

B. Alternating the operation of all ultrasound transducers (all transducers are transmitting and receiving at different times).

C. Using fully synchronized ultrasound transmission for all transducers.

Method A

Method A requires different sensors (containing different ultrasound crystals) for each fetus. This makes application complicated for the user, as each heart rate channel requires a different transducer. Finding the right transducer and sharing transducers within a hospital becomes problematic, more transducers are needed per hospital, and more spare parts need to be stocked. Consequently, Philips does not use this method.

Method B

Method B alternates operation of all the ultrasound transducers, so the higher the number of fetal heart rates you measure, the shorter the time that any specific transducer is active. This means that when monitoring twins, each ultrasound transducer is active only half as long as when monitoring a single fetus. Extend this to triplets, and each transducer is active only one-third of the time. The result is a dramatic reduction in sensitivity, signal quality and therefore performance, with the consequence that weak ultrasound signals may not be detectable. In view of these drawbacks, Philips takes a different approach.

Method C: The Philips Solution

Philips fetal monitors use fully synchronized transmission for all ultrasound transducers, and this approach avoids all the disadvantages associated with methods A and B. Philips ultrasound transducers are fully synchronized in terms of ultrasound frequency, burst repetition frequency, and the timing of transmission and reception.

Synchronized ultrasound frequency: Even a small difference in the ultrasound frequency between transducers can result in clearly audible noise. To avoid this problem, all Philips ultrasound transducers utilize exactly the same frequency. In fact, all Avalon ultrasound transducers can be interchanged and combined for triplets monitoring. You can take any three Avalon ultrasound transducers in your hospital without having to worry about where they come from or how they are combined. The Philips solution makes handling transducers simple, and means that fewer transducers are required in total, making triplets monitoring convenient and efficient, saving you time.

Burst repetition frequency and timing: When ultrasound transducers are transmitting and receiving at different times, a strong transmitter signal can mask a weak echo of another transducer when one transducer is transmitting while the other is receiving. To avoid this, all ultrasound transmission bursts have exactly the same burst repetition frequency, and are started at the same time. So all transducers are transmitting at the same time, and receiving at the same time.

Each fully synchronized transducer has its own central processing unit (CPU), so there is a separate processing channel for each heart rate. This means that when monitoring multiple fetal heart rates, the sensitivity for each transducer is not compromised, and the performance is the same as when monitoring a single fetus. The performance of the fetal monitor remains unaffected regardless of how many heart rate channels are being monitored.

What You Need to Monitor Triplets

To monitor triplets, simply:

- Order the appropriate monitor software option to enable triple FHR monitoring via ultrasound.
- Have three Avalon ultrasound transducers (M2736A) available.

For details of measurement and accessory options, contact your local Philips sales representative.

Frequently Asked Questions

The following frequently asked questions, with their answers, may provide you with some useful information or tips regarding triplets monitoring.

Q.I am finding it difficult to locate the third fetal heart rate using the sound from the transducer. What should I do?

A.Locate the third fetus using palpation and/or an ultrasound scanner to determine the fetal position, and the location of the fetal heart. Then reposition the transducer using sound, and fix the transducer in place when the signal quality indicator is showing a good signal.

Tip: sometimes you may find it helpful to tilt the transducer at the cable boot end to make sure the ultrasound beam stays focussed on the fetal heart.

Q.The symbol ? appears on the screen next to the FHR label, and ? is repeatedly printed on the fetal trace recording. What does this mean?

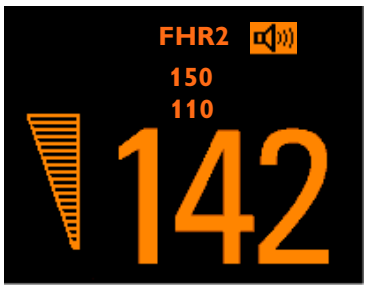
A.This is the monitor's Cross- Channel Verification (CCV) feature indicating that the same heart rate is being recorded by more than one transducer (see "Cross-Channel Verification" on page 2).

On the trace recording, you can see which heart rates are coinciding:

Once you know which heart rate channels are coinciding, reposition one of the transducers using sound to make sure you are monitoring two distinct heart rates.

Q.I can only hear the heart sounds from one FHR channel, and would like to hear the heart sounds from a different fetus. Can I do this?

A.Yes you can. You can listen to one fetal heart rate channel at a time. When the fetal heart sound is selected for a FHR channel, you see the audio source symbol next to the FHR numeric label for that channel.



To select the audio source for a different FHR channel:

Enter the **Setup FHR** menu for the channel you want to hear.

Press **Select Audio**. It may take a few seconds for the audio source symbol to appear.

Q.The signal quality indicator for one of the FHR channels is empty, and the numeric has disappeared from the screen. What should I do?

A.There is signal loss on this FHR channel, and you need to reposition the transducer to obtain a good signal again. Note that fetal movement can cause signal loss.

To identify which transducer needs repositioning, touch the FHR channel's empty numeric on the screen. This illuminates the Finder LED of the relevant transducer, so you can easily find the transducer.

Select the fetal heart sound for this FHR channel, and make sure the audio volume is at a clearly audible level. Reposition the transducer using sound, and make sure that the signal quality indicator is full, indicating good signal quality. Allow about 30 seconds for the signal to stabilize.

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